The Zha et al. patent discloses a membrane module 4 that includes a bundle of hollow fibre membranes 5 extending longitudinally between upper and lower potting heads 6, 7. A porous tube 16 may be inserted into the center of the membrane module 4.

Neither the '074 reference nor the Zha patent disclose or suggest an "injection means for injecting . . . gas to a central portion of [a] plurality of hollow fiber membranes . . . wherein the gas . . . spreads said plurality of hollow fiber membranes outwardly." The office action incorrectly suggests that this claimed feature is disclosed in the '074 patent with reference to either the raw fluid inlet 1 or the gas supply inlet 4. Applicant respectfully disagrees.

First, the raw fluid inlet 1 in the '074 reference is not an "injecting means for injecting *gas*" as recited by claim 2. (*Emphasis added*) Instead, the raw fluid inlet 1 merely provides a path for raw fluid to enter the housing 6.

Second, the gas that passes through the gas supply inlet 4 in the '074 reference does not "spread [the] hollow fiber membranes outwardly," as recited by claim 2. Instead, according to the '074 reference:

> "[d]uring the backwash process . . . gas is supplied through the gas supply inlet 4 . . . in order to cause a reverse flow of filtered fluid stored in the storage space 5 and thereby remove the dirt . . . which have adhered to the to the surface of the membranes. The removed dirt, etc. is discharged outside the hollow fiber membrane module through the raw fluid outlet 2." (*See* page 3 of the '074 translation, lines 31 – 36)

The gas does not "spread [the] hollow fiber membranes outwardly" as recited by claim 2.

One of skill in the art would recognize that certain advantages may be realized by the claimed subject matter. For example, the hollow fiber membranes may remain clean for an extended period of time. This may be due to, for example, the highly turbulent nature of the fluid/gas mixture inside the filter cylinder during filtering, the frequent (nearly continuous) fluttering of the hollow fiber membranes due to the turbulence, or the gas bubbles moving

through the fluid further assisting in removing dirt from the hollow fiber membranes. Such improved cleanliness may, in some instances, result in improved filtering efficiency and may also extend the period of time between required maintenance sessions of the filter device.

The Office Action suggests that certain aspects of the claim language should not be considered in determining the patentability of the claims because they describe "process." For example, the Office Action states:

> "the floating bubbles spreading the fibers (as in claim 14) and removing the deposits is 'process.' Even though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself." (*Some internal quotations omitted*)

However, the claim 2 limitations discussed above, specifically, an "injection means for injecting . . . gas to a central portion of [a] plurality of hollow fiber membranes . . . wherein the gas . . . spreads said plurality of hollow fiber membranes outwardly" are not product-by-process limitations and should be factored into the claim's patentability determination.

A product-by process claim "is one in which the product is defined at least in part in terms of the method or process by which it is made." *Bonito Boats v. Thunder Craft Boats, Inc.* 489 U.S. 141, 159 (1989) (citing D. Chisum, Patents § 8.05, p. 8-67 (1988)). In the present case, the filter device recited in claim 2 is not being defined in terms of the method or process by which the filter device is made. Instead, the features discussed above describe elements that are arranged to interact in a particular manner during operation of the filter device. Accordingly, these limitations should be considered in making a patentability determination.

Each of independent claims 4, 7 and 14 recite limitations that are similar to the limitations discussed above with regard to claim 2. Accordingly, these claims should also be allowable for at least the same reasons as claim 2. Claims 5, 8, 9, 10 and 11 each depends from an allowable claim and should therefore also be allowable.

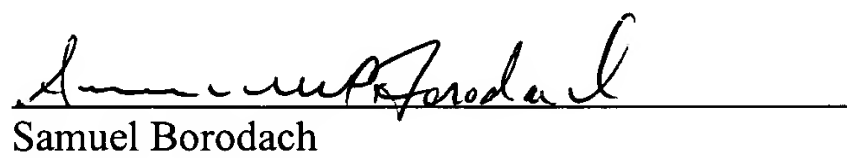
Independent method claim 13 recites a method that includes "providing a plurality of hollow fiber membranes . . . having . . . a second end that is free; enabling the free ends to spread . . . injecting . . . gas into a central portion of [a] plurality of hollow fiber membranes; and causing the . . . gas to radiate outwardly." For reasons similar to those discussed above, Applicant submits that neither the '074 reference nor the Zha reference discloses or suggests such features. Accordingly, Applicant respectfully submits that claim 13 also is allowable.

It is believed that all of the pending claims have been addressed. However, the absence of a reply to a specific rejection, issue or comment does not signify agreement with or concession of that rejection, issue or comment. In addition, because the arguments made above may not be exhaustive, there may be reasons for patentability of any or all pending claims (or other claims) that have not been expressed. Finally, nothing in this paper should be construed as an intent to concede any issue with regard to any claim, except as specifically stated in this paper, and the amendment of any claim does not necessarily signify concession of unpatentability of the claim prior to its amendment.

Please apply any charges or credits to deposit account 06-1050.

Respectfully submitted,

Date: November 16, 2004



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HOLLOW FIBER MEMBRANE MODULE

The present invention relates to a hollow fiber membrane module.

Background art

The hollow membrane module is known for being compact and for providing a large effective membrane area, thus being used in industrial and medical fields for filtrating or separating fluids or gases, etc. Hollow fiber membrane modules are divided in two classes according to the filtration process used. One of the methods is the internal pressure filtration method according to which raw fluid is caused to contact the inner surface of the hollow fiber membrane and filtered fluid which has permeated the membrane is discharged from the outer surface of the hollow fiber membrane. The other method is the external pressure filtration method, where the process of filtration is the opposite of the internal pressure filtration method. Generally, the internal pressure filtration method is suitable in circulation-type filtration, whereas the external pressure filtration method is used in all types of filtration, also considering the properties of the raw fluid.

When the filtration process has been carried out for a longer period of time, dirt, SS particles, etc. adhere to the surface of the membrane causing a drop in filtration speed. In order to prevent the drop in filtration speed and enable a longer stable filtration process, the filtered fluid that has permeated the membrane is flow-reversed by use of a pump at regular intervals in order to peel off dirt and SS particles, etc. that had adhered to the membrane and restore filtration speed. (a process called backwash). In order to carry out the backwash process, a backwash pump for reversing the flow of the filtered fluid, and a backwash tank for storing filtered fluid are provided in a conventional filtration apparatus. The conventional backwash pump and backwash tank present the following problems: a) compactness is lost because overall size of the filtration apparatus becomes large; and piping and other electrical equipment are necessary for installing the backwash pump and the backwash tank, thus causing an increase in the overall cost.

Summary of the invention

The present invention provides a hollow fiber membrane module to be used in a filtration apparatus which solves the above described problems and enables, at the same time a long and stable filtration process due to a process of backwash using the filtered fluid.

The hollow fiber membrane module of this invention uses an exterior pressure filtration method wherein a chamber is formed in a housing provided with a plurality of hollow fiber membranes, and a space (storage space) is provided in the chamber for storing the filtered fluid that permeated the membrane, wherein a capacity of the storage tank is set to be around 10 to 70% of the overall capacity of the hollow fiber membrane module.

The hollow fiber membrane module of the invention is provided in the chamber with a storage space for storing the filtered fluid, as described, which plays the role of a backwash tank during the process of backwash using the filtered fluid. A filtration apparatus provided with the module of this invention no longer needs to include a backwash tank, so that it becomes compact and reduces cost associated with installation thereof.

First embodiment

The hollow fiber membrane module of this invention comprises a housing 6 including a plurality of hollow fiber membranes 7, and a chamber 10, as shown in Fig. 1. The hollow fiber membranes 7 are fixed by a fixative resin 8 so that openings are created at upper edges thereof, whereas lower edges thereof are individually molded by the fixative resin 8. Lower edges of the hollow fiber membranes 7 can also be molded in a batch or can be folded back in a U –like shape. It is also possible to create openings at lower edges of the membrane and then fix them by the fixative resin 8.

The hollow fiber membrane is made of any conventionally known material, without limitation, such as cellulose, polyamide, polycarbonate, polyvinyl alcohol, polysulfone, polyacrylonitrile, accetylcellulose.

The fixative resin 8 fixing the hollow fiber membranes 7 can be made of any material used in conventional resins for molding edges of or fixing the hollow fiber membranes, without limitation, such as polyurethane, silicone, epoxy, etc.

A raw fluid inlet 1 having a raw fluid supply path (not shown) including a valve 1 and a raw fluid outlet 2 having a raw fluid discharge path (not shown) including a valve 2 are provided in the housing 2. The chamber 10 of the housing 6 is fixed by a fixative jig 9 such as a sanitary clamp. Any other means for fixing the chamber can be used here without limitation. The chamber 10 and the housing 6 can form an integrated body by means of the fixative resin 8.

A storage space 5 is provided in the chamber 10 for storing the filtered fluid that has permeated the hollow fiber membrane, but it also has the role of a backwash tank during the backwash process.

The capacity of the storage space 5 is preferably set to be about 10 to 70% of the overall capacity of the hollow fiber membrane module, but the optimum capacity setting is between 20 to 50%. Here, the overall capacity of the hollow fiber membrane module means a combination of the capacity of the housing 6 and that of the chamber 10. In case the capacity of the storage space 5 is less than 10% of the overall capacity, it is impossible to secure a sufficient amount of filtered fluid o carry out an efficient backwash process. Also, in case the capacity of the storage space 5 is over 70% of the overall capacity, the rate of the effective membrane area in the hollow fiber membrane module is relatively decreased, thus causing a drop in filtration capabilities of the module and also an increase in the amount of filtered fluid used during the backwash process. In the conventional module shown in Fig. 3, the capacity of a portion corresponding to the storage space 5 of the invention is set to about 5% of the overall capacity of the module.

A filtered fluid outlet 3 is provided on an upper side of the storage space and a filtered fluid discharge path (not shown) having a valve 3 is connected thereto.

Also, a gas supply inlet 4 for supplying gas causing the filtered fluid to reverse flow is provided in the chamber 10. A gas supply path (not shown) having a vent 4 is provided in the gas supply inlet 4. In the module shown in Fig. 1, the gas supply inlet 4 branches from the filtered fluid outlet 3, but the inlet 4 can be provided at other positions too.

In the filtration process using the module of the invention, vent 1 and vent 3 are opened and vent 2 and vent 4 are closed in order to supply raw fluid stored in a tank (not shown) into the hollow fiber membrane module via a raw fluid inlet 1. The fluid that was filtered through the hollow fiber membranes 7 is stored in the chamber 10 and is then discharged from the storage space 5 via the filtered fluid outlet 3 after passing through the filtered fluid discharge path. If the vent 2 is opened, a circulation-type filtration can be obtained. After the filtration process has been carried out for a certain amount of time, dirt, SS particles, etc. adhere to the surface of the hollow fiber membranes 7 causing a drop in filtration speed. In order to remove the dirt etc. that adhered to the surface and thereby restore filtration speed, a backwash process is carried out. During the backwash process, after vent 1 and the vent 3 are closed and vent 2 and vent 4 are opened, gas is supplied through the gas supply inlet 4 via the gas supply path in order to cause a reverse flow of the filtered fluid 5 stored in the storage space 5 and thereby remove the dirt, SS particles, etc. which have adhered to the surface of the membranes. The removed dirt, etc. is discharged outside the hollow fiber membrane module through the raw fluid outlet 2. After the backwash

process is completed, when raw fluid is supplied in the module (flushing process) by opening vent 1 and vent 2 and closing vent 3 and vent 4, the removed dirt, etc. can be more effectively discharged outside the module.

As described above, the module of this invention is provided with a storage space 5 for storing the filtered fluid, so that the overall filtration apparatus including such a module no longer needs a backwash tank as in the conventional art, thus becoming more compact and cost-effective.

Another method that can be used for supplying gas into the module is by using a backwash pump. Still, when a method of supplying gas inside the module is preferably used for causing a reverse flow of the filtered fluid, it is no longer necessary to install a backwash pump as in conventional filtration apparatuses, so that the overall apparatus becomes more compact and cost-effective.

The methods which can be used when gas is supplied inside the module are either by providing a gas supply inlet 4 in the chamber 10 of the module and then directly supplying gas inside the module, or, by providing a branch path in the filtered fluid discharge path and supplying gas inside the module through this path. However the method according to which a gas supply inlet 4 is provided is preferably used.

The gas supplied inside the module can comprise without limitation inactive gases such as air, helium, azote, argon, etc. Also, the pressure of the gas to be supplied can be set at a higher value than the differential pressure between membranes at the time of the filtration in order to enable more efficient restoring of the filtration speed. It can be set between 1kg/cm↑2 to 10kg/cm↑2, and preferably between 2kg/cm↑2 to 5kg/cm↑2.

Second embodiment (Fig. 2)

In the hollow fiber membrane module of this embodiment, lower edges of the hollow fiber membranes 7 are molded in a batch and fixed by the fixative resin 8. Also, the gas supply inlet 4 is provided separately from the filtered fluid outlet 3. The rest of the configuration is same as the one described in the first embodiment.

Example of a filtration process using the module of the invention:

A hollow fiber membrane made of polysulfone and having an effective length of 1m is used; the effective membrane area is 6m↑2 and the capacity of the storage space is set to be 25% of the overall capacity of the hollow fiber membrane module. Here, wine is used as the fluid which is filtered using the module of the invention. The relationship between the filtration amount and the filtration speed is shown in Fig.4. Filtration conditions are as follows:

Raw fluid: white wine

Filtration type: exterior pressure filtration

Intermembrane differential pressure during filtration: 1kg/cm↑2

Pressure of supplied gas: 3kg/cm↑2 (azote)

Backwash time: 30 minutes

Flushing: 15 minutes

During the backwash process, the filtration speed is largely recovered so that filtration can afterwards be carried out stably for a long period of time.

Claims:

1. An external pressure-type hollow fiber membrane module having a housing comprising a plurality of hollow fiber membranes, and a chamber, wherein a space is provided in the chamber for storing a filtered fluid and wherein a capacity of the space for storing the filtered fluid is set to be around 10 to 70% of the overall capacity of the hollow fiber membrane module.

2. The hollow fiber membrane module of Claim 1, wherein a gas supply inlet is provided in the chamber.

Abstract

An external pressure-type hollow fiber membrane module having a housing comprising a plurality of hollow fiber membranes, and a chamber, wherein a space is provided in the chamber for storing a filtered fluid and wherein a capacity of the space for storing the filtered fluid is set to be around 10 to 70% of the overall capacity of the hollow fiber membrane module. This module no longer requires a backwash pump or a backwash tank as with the conventional art in order to carry out efficient filtration, so that the overall apparatus becomes compact and cost-effective.